ON SOME RELATIONS OF CHEMISTRY TO MEDICINE.

ADDRESS

TO THE

MEDICAL STUDENTS

AT THE OPENING OF THE WINTER SESSION,
UNIVERSITY OF GLASGOW,

TUESDAY, OCTOBER 30, 1877.

BY

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ADDRESS.

It has fallen to me, in the name of my colleagues, some of you to welcome back to the University, others to congratulate on having made choice of the profession of Medicine for the future work of your life.

Those who have occupied this place before me have been in the habit of addressing to their audience some words of advice and encouragement, and I should myself endeavour to follow the example which has been thus set. From the peculiarity of my own position, however, I feel that I am not entitled, by formal qualification or by practical experience, to point out to those who are about to enter on the study of so wide a subject as medicine, how they should set about the arrangement of their whole work.

It would be easy, indeed, to state in general terms that the qualities which ensure success in other fields of human endeavour—unremitting attention, hard, persevering, unflinching work, the capacity of taking pains —will enable a student to become ultimately a qualified physician; but such a statement is too general to produce

the effect desired. Easy, I say, would it be to reiterate, in the way of precept, phrases which must be familiar to you all about diligence, and the improvement of what, in a city like this, may still by courtesy be called "each shining hour"; the difficulty is for you to induce yourselves to act as these ancestral precepts direct. In the effort some will succeed by their own love of work, or by the great desire "to get on"; others will be assisted by the example, perhaps by the rivalry, of their companions; but it is possible that by my exhibiting some of the aspects under which the study of medicine offers itself, you may be induced to consider it more minutely yourselves, with the express purpose of utilizing your time to the utmost. The views of an outsider like myself may be not inappropriately addressed to those who are just beginning medical study, and who have doubtless formed some idea of what is important for them and what not—what, therefore, should have the best of their attention and what may be more lightly passed over, as not having obviously any immediate or ultimate bearing on their profession.

The whole subject of medical study is much too extensive for a single discourse; I confine myself perforce to one part, and will try to explain what seems to me the position of the subject I have to teach you with respect to some other branches of medical study. I gladly avail myself of an opportunity for this explanation, for I have a suspicion—which may possibly be unfounded

—that chemistry has never been, and is not now, one of the favourite subjects of the curriculum.

That this is so arises from a misconception of the nature of the science. It is doubtless thought that it is absurdly extensive, that chemists take a perverse pleasure in gratuitously enlarging its area, and that while it is sport to those whose whole time can be devoted to it, it is death to those who, like medical students, have other aims and tastes. Those who come to its study for the first time (and those who have to study it in connection with medicine are specially included), are struck by the novelty of aspect which the world of matter puts on. The enormous variety in that world seems to the ordinary observer to be out of all connection with the pursuits of everyday life, to have no real significance, to be of no importance for them; but the chemical student is soon made aware that the whole material universe, or at all events the whole of this planet, is made up of substances, in the compounding of which the strictest regularity is maintained, that there is no chance-work in the variety, and that many trivial or apparently indifferent bodies are of the greatest importance in the economy of nature. To this feeling of novelty succeeds naturally one of despair of ever mastering all that is known about the thousands of distinct substances, each with its own characters, its own definite composition, its own behaviour when brought into chemical contact with others. There is, I admit, some cause for this—the subject is coextensive

with the material universe, the time allowed for acquiring merely an outline of the best established facts and laws is very short, and the opportunities, of which medical students might avail themselves, of acquiring direct familiarity with a larger number of substances than they do, are curtailed by their having more pressing calls upon their time and attention. Thus, unfortunately, their time has to be spent in what is called "reading," whereas if even a small proportion of the time could be otherwise applied, for example, to the examination of typical specimens, a much more real and profitable knowledge of the science might be acquired.

From the pressure upon the curriculum, the student cannot well afford to carry his studies much beyond the elements, and take up those sections of chemistry in which at a more advanced stage he would find immediate professional interest. It thus too frequently happens that chemistry is dropped at the end of the second year, and what has been learned, often with great painstaking, is allowed to fade out of mind. It would be of the greatest service to students, on the contrary, if they could persuade themselves to pursue the study of this science, on account of its bearings on their subsequent work, and even on their future professional skill. This, however, is not apparent at first sight, and in the desire to attain their end students are apt to neglect the means.

What has a medical student the opportunity of learning during his residence at the University?

1. Science, and training in scientific observation and reasoning.

2. A certain amount of knowledge and information.

3. Initiation into professional practice.

Of these three the most important for the actual physician is practice, because it is through it that he consolidates his knowledge and science, sifts the true from the false, or, in other words, acquires experience. But, for the student, the most important thing is the acquisition of the best knowledge from those whose business it is to impart it, and of the scientific method by which that knowledge has been gained. But the student is too apt to invert all this—to work in the hospital or engage in private cases as soon as possible, before he is in a position to stand an examination on the mere rudiments of medical science; that is, to undertake the most difficult work of curing, before he knows the principles—such as they are—on which the cure is to proceed. It would be as reasonable for a school-boy to insist upon reading Tacitus, before he knew his declensions.

This grasping at the goal before running the race is a phenomenon, however, which is seen not only in the growing efforts of an individual mind, but is to be observed in the growth of medicine itself, and of science as a whole, and is nowhere more conspicuous than in what has been called "Medical Chemistry."

If we examine the growth of chemistry as a science,

we see that at an early period its immediate aims were comparatively restricted, while its theoretical principles were too wide to be of much direct use in attaining those aims. But as knowledge of the properties and composition and mutual actions of matter extended, and was applied more immediately to the arts of life and also especially to medicine, and as the knowledge of general chemical principles extended simultaneously, the latter were thought to be so universal in their range that medicine, in theory and to a great extent in practice, continued for a time to be little else than a branch of chemistry. This singular period in the history of both pursuits is known as that of "Iatro-chemistry." From the beginning of the 16th to the middle of the 17th century, for well nigh a century and a half, these views prevailed and had a distinct influence on the developments of both chemistry and medicine. It was not merely that chemical remedies, such as compounds of mercury, antimony, copper, iron, salts of various kinds, active substances obtained from plants and animals and so on, were introduced into the pharmacopœias of Europe, and that their introduction was attended with fierce disputes and reciprocal abuse on the part of the upholders of the ancient Galenic system, and those who wished to introduce the newer remedies, but the origin of the diseases themselves was ascribed to chemical principles alone. If this were the fitting occasion, it might be shown you in detail, how complicated physiological and

pathological actions, which are unexplained even now after all the progress of two hundred years, were disposed of easily to the satisfaction of the then medical theorists by an application of one of the most obvious of ordinary chemical reactions. The enormous complexity of the problems in disease was unknown, unnoticed, and their solution was consequently thought to be quite simple. The same thing is at work in the mind of the untaught and inexperienced of all ages.

These mere hypotheses, however, being far wider than their real foundation, led at last to their own overthrow, and this form of the connection between chemistry and medicine passed away never to return. Succeeding the Iatro-chemical period there came another, in which, while the chemists were still medical graduates, and in many cases distinguished physicians, they became aware of the difficulty of explaining and harmonising the differences and obscurities in the most obvious chemical phenomena, and gave up the attempt to bring those of vital chemistry within the general principles which they had devised to suit less subtle actions. So long, in fact, as they did not understand what the air is, or whether the metals are simple or compound, or what takes place when a piece of wood is burned, they seemed to have felt that it was hopeless to attempt an explanation of the changes which take place in a plant or an animal, or to affirm whether or not they are even the same in kind.

It is of great importance to remember that the first real

discovery in animal chemistry, the first well ascertained fact which was to reunite chemistry and medicine, not in a fanciful manner, but on a firm experimental basis, was not made of direct purpose, but, like so many other discoveries, was the outcome of an investigation pursued in a totally different direction and with quite a different intent.

The discovery to which I allude was a consequence of the enquiry into what had all along been the central problem of chemistry, namely, the explanation of combustion. What happens when any ordinary substance, like a candle, burns in the air? What happens when a metal, like iron, rusts in the air? The answer to these questions had run in one groove from the earliest times of which we have record, down to the middle of last century, and then, after the hitherto received answer had been debated for upwards of a dozen years, it was found to be insufficient and a new one was given. This long discussion not only widened men's powers of generalizing but also brought to light a great number of new experimental facts and among them was this: A candle burns when the materials composing it unite rapidly with one of the gases contained in the atmosphere, giving rise thereby to certain new substances, and evolving likewise light and heat; an animal, say man, is composed largely of the same ultimate elements as the candle: he inhales the air, and produces the same effect upon it that the burning candle does, and gives rise to the same products. In brief, combustion

and respiration were seen to be chemically identical ; they are both actions of oxidation. When a burning candle is deprived of air, the flame is extinguished ; when a living man is deprived of air, respiration being stopped, death ensues. As soon as this was established, it followed that whatever else the body may be, it is the locality of a known common chemical action, and, as respiration is essential to life, this chemical action with all its products, intermediate and ultimate, and all its concomitant effects, must be of prime importance to life.

This fundamental fact in physiological chemistry was obtained, therefore, not by a primary examination into the nature of respiration, but as a consequence of three previous factors—of Black's examination of the cause of the difference between limestone and lime, of Priestley's discovery of oxygen, and of Lavoisier's dozen years' crusade against the hypothesis of Phlogiston. It was, however, but the beginning, for little or nothing was known of the composition of the materials of the body ; even the methods of investigation had to be invented, and the very chemical reagents which we now use familiarly formed separate discoveries, and even marked epochs in chemical history. And here again we see how the first great pretensions and wide aims of investigators are curtailed by the vastness and abundance of nature, and how, in the attempt to solve one problem, so many others, preliminary and subsidiary, requiring to be disposed of, occur, that one may never be able to overtake the main matter. At the beginning of

the study of organic chemistry some eighty years ago, substances were examined the relationships of which are pretty well understood now, because in the interval two or three generations of chemists have been engaged with those subsidiary questions I have referred to, have worked, discussed, argued, have been right and been wrong, and have passed away, leaving us to profit by their energy and errors, and to gather the results of the truths they have jointly established.

Thus so slowly and so indirectly has the composition of the body been partially ascertained. So slowly has it come to be seen that there is no such division as that which formerly prevailed between organic and inorganic chemistry. At present we believe that though the conditions of chemical change in the body are more numerous and intricate than those to which we can subject substances in the laboratory, they are not different in kind, since the products and educts are the same in both.

And thus through the independent pursuit of chemistry as a science—through the examination of the different changes matter can undergo without reference to any practical application, the connection between two subjects which are essentially more apart than ever, chemistry and medicine, has been re-established on a quite new basis, one far firmer and wider, far more intimate and profitable, than when they were supposed to be identical.

It requires no great prophetic gift to see that, in future, chemistry instead of diminishing will enlarge its relations

with medicine. I do not here allude to the assistance rendered by chemistry to pharmacy in supplying such potent substances as chloral, salicylic acid, carbolic acid, and the vegetable bases such as strychnine, and morphine, and the still greater assistance it will render in future; or to its importance in sanitation; or to its forming part of forensic medicine; all these connections are already well established—indeed, the physician can hardly turn himself without making use of chemistry in some form or other. I speak now of a more direct relationship. As all the sciences progress, their relations and interdependence become more and more marked and, in our particular case, physicians will be necessitated to avail themselves of the improvements which the increasingly minute examination of the animal economy, both in its healthy and morbid states, will involve. As yet they have made but limited use of chemical analyses of morbid products as a help to diagnosis, and it may be possible that, in many cases, the physiological link between the amount of a given substance in a tissue or fluid and the nature of a disease being awanting, they may be right in saying that chemical analysis is not of practical use.

Time was when manufacturers in this country held the curious notion that science was a disadvantageous thing; but it has been driven in even upon them by the result of competition and otherwise, that science is really less detrimental to them than they supposed. The manufacturers of health, the physicians, hold a not dissimilar notion. But

this arises from their confusing chemical analysis, the detection and estimation of a given substance, and the reactions by which it may be formed, with the deductions they have to make regarding the morbid states of which it may be the consequence or cause.

This state of things, however, cannot endure always. The connections will be made out here as they have been in other departments of the science, and the chemical laboratory and the regular chemical report will become as indispensable in the hospital, as they are now in many manufactures. It may not perhaps be requisite, or even desirable, that every physician should be an expert zoo-chemist, but he should know the nature of the work sufficiently to be able to propound the question he wishes answered, he should know the limits of accuracy of the chemical methods employed and the conditions of the enquiry. That amount of knowledge would prevent one's receiving, as one does occasionally, a little fluid in a bottle with the vague request that it be analysed within the next few hours. Such a request can be made only by one who is unacquainted with analytical methods, and especially with those of zoo-chemistry.

In view of these requirements it becomes a matter of paramount importance for the student to make the most of his time, for it is difficult to see how, in the future, he is to overtake, in the period allotted, the work which is gradually accumulating upon him by the unavoidable progress of science. At present there are tendencies at

work which increase the difficulty, more especially the development of practical teaching in every department, the compelling the student to work with his hands and eyes, as well as to read books, while the total amount of time which the whole curriculum occupies is not lengthened. A modification, however, tending in this desirable direction, has just been made, of which many of you are already aware, but the nature of which I may briefly explain in passing. Hitherto the course has begun in winter and lasted for four years; and it was not until the beginning of the third year that the student could show what progress he had made in the previous subjects. But by a revision of the Ordinance, which has been approved this autumn by the Queen in Council, an alteration in the terms of examination has been effected, which, it is believed, will be much prized by the students. By this alteration those who choose to enter the medical classes in summer will be able to complete the subjects of the first examination in eighteen months and be examined on them before proceeding to study those included in the second examination, and so on for the following. In this way they will be able to devote their entire attention to the subjects of each successive session, without that overlapping of what may be termed *real* study, as distinct from mere preparation for examination, which, in the past, has frequently been felt so burdensome. This, which is an undoubted advantage, will, it is hoped, be followed by a corresponding improvement in what are called the scientific preparatory subjects, and by

the attainment of a still higher standard of knowledge and skill.

It is impossible to overrate the importance of these preparatory studies, and yet it too often happens that through want of knowledge of how and what to study, much of the earlier sessions is lost. In the short residence at the University you have to acquire some acquaintance with ten or a dozen subjects, each of which has a long history and has reached its present state by slow growth, and each of which is more than enough to occupy the undivided attention of a lifetime. No one can expect you to get more than a general knowledge of these, no one would require of you a critical familiarity with any one of them.

But how much of them is profitable for your profession? I shall confine myself again to chemistry as that with which I am most familiar. What part may chemistry claim to occupy in a medical curriculum?

The object of the curriculum is to qualify the student to be a physician—a special education in which the student sacrifices part of his general self-culture to make himself more apt as a means to accomplish an object outside himself. The aim of all medicine is to prevent disease and to cure it. The physician, as I said before, is a health manufacturer. The object of the physician's operations is the body, and the body is material and perishable. Life, physical, is the free performance of certain functions or acts, and, in the performance of these, the matter of which the body is composed is ceaselessly undergoing change. Sometimes the

body is so affected that the natural changes are accelerated, or retarded, or stopped, and this is a state of disease; and, when the abnormal state becomes extreme, the bodily machine breaks down, and death is the ultimate result. The physician then must know the normal condition of the body, be able to recognise the origin and nature of any disorder in it, and he has to restore the body, if possible, to its normal state.

Observe then that the first thing he must know is the structure, composition and functions of the body, and each of these forms a distinct preliminary branch of medical study.

1. The structure, position, relations, and connexions of the different parts are explained by anatomy.

2. The composition of the different parts, their mutual reactions, and the way they are altered by contact with other substances, are ascertained by chemistry.

3. The functions of the different parts, which flow from their structure, composition, and changes, form the complex science of physiology.

These three subjects are indissolubly connected, and thus chemistry is absolutely essential to the education of the physician.

As it is the science which is concerned with the composition and mutual actions of all kinds of matter, it must of necessity take cognizance of the body as a complicated mass of matter, which displays chemical changes under very peculiar conditions. As concerned then not merely

with the dead, but even more with the living body, physiological or zoo-chemistry—including, if you choose, pathological, that is the chemistry of disease—ought to be one of the most important divisions in a medical course.

But, as it happens, and I have shown you already the historical significance of the fact, animal chemistry is the most difficult department of the science, and it becomes intelligible only after the student has mastered the general principles of the science itself, is familiar with the reactions of inorganic bodies and has knowledge of the nature of carbon compounds in general, or, as it used to be called, of organic chemistry.

From this you will see that chemistry has two parts to play in the *training* of the physician.

1st. As a preliminary discipline. In so far as medicine is a practical art and is based upon consideration of material phenomena, the first requirement of the student is how to deal with these. For this purpose chemistry is especially well adapted, because it is not merely a science of observation, it is one in which the observer must educe the phenomena he desires : in practical chemistry therefore one is exercised not only in observing and describing, but in planning the mode of getting the result, using the best means, and, in this way, finally obtaining the chemical action. Of course, for this purpose, the student must begin with the simplest experiments and pass to the more difficult. The beginnings of the science, and the principles of the science, are the same for all—and there is nothing pre-

posterous, as some of you may have been told, or as some of you may think, in one who is going to be a physician and one who is going to be a metallurgist, or a mineralogist, or a calico printer, listening to the same course of lectures on the science. It is sometimes said that medical students should have medical chemistry and manufacturing students technological chemistry. That may be, afterwards; granting that such differences are real, and not simply invented for convenience by those who make use of the science as a means to some other end; but it would be as correct to say that, at an English school, boys who are to be doctors should be taught to read only medical English, and future clergymen only theological English, and future members of Parliament only blue book English; but what in that case would come of the "well of English undefiled"?

2ndly. The second part chemistry plays is as one of the main pillars of medicine—a pillar on which the science will have to depend more and more, as I have already indicated. It is by it that the physiologist finds out the working of the human machine, by it that the physician even now sometimes discovers the derangements of the machine, from it that he derives the materials for reinstating it in health.

The comparison of the human body to a machine, say, to a watch, or a steam engine, has been made so often, that I should not have made it again, except to draw your attention to some of the essential differences between them which must be obvious to any one who considers the subject for a

moment, and must be specially apparent to the physician or surgeon.

A watchmaker or engineer studies the construction of his machine by taking it to pieces, observing the form, arrangement, and reciprocity of its parts. So too does the anatomist. A watchmaker or engineer can recombine the parts of the machine and set it a working. It is only Frankenstein, the anatomist of romance, who has as yet succeeded in doing this with a human machine. Observe the machines in action. So long as the working conditions are complied with, so long as the engine is coaled, the watch wound up, the man fed, the actions dependent on these will ensue, and no interference is necessary.

Suppose, however, a piece of the machine gives way or the man falls ill, we shall immediately see the difference between the engineer and the physician. The engineer stops the machine, probably it has stopped of itself, finds out what has gone wrong, removes what has given way, supplies a new piece, and starts the machine as before. The physician cannot do this: he cannot stop the human machine, find out what is wrong, remove the disordered fluid or tissue, put a fresh one in its place, and start anew. He must judge of what is wrong, sometimes only by remote and obscure effects, and even while yet uncertain of the exact nature of the disorder, he may have to do something, say, to alleviate pain or procure rest. And after he has ascertained what is wrong and is in a position to deal with it, the success of the cure

may be influenced by the condition of the patient, the manner in which remedies may affect him, his readiness to receive and assimilate food, and so on. For after all it is the "power of nature" which works the cure, by being diverted from a fatal to a healing issue.

Let us consider what would be a like problem for the engineer. In the first place the injury must not cause the stoppage of the whole machine, and he must find it out only by the derangement. Then he must supply not a ready formed corresponding part, which is to be inserted mechanically in place of the injured portion, but he must supply the raw materials to make the mend. Suppose the axle of a locomotive snapped—he is not to remove the broken pieces; he must not put in a whole new axle, or new pieces, or even ready formed iron rods or bars; but he is to supply his locomotive with blackband ironstone and leave it to smelt the iron, fabricate it into the right shape, and deposit it only at the place of fracture. Doubtless the engineer would consider a locomotive which would repair itself a very singular phenomenon; he would probably find great interest in studying such a combination and illustration of physical and chemical principles, and he would probably feel that he ought to be well skilled in these sciences before venturing to interfere with it. It is well for you to consider this: for by how much more complicated the human body is than any machine or combination of machines, by how much more complex and

unstable the materials of its solid and fluid parts are than those of any machine; by how much more obscure the changes these materials undergo, and the relations which these changes bear to its normal and abnormal states than those in any machine; by so much more complicated and difficult is the problem of the physician than that of any worker with dead matter.

When one considers the severe training in physics and mathematics required to enable the engineer to understand his simple problems, it must be despair of applying these and other sciences, which causes the physician to dispense so often with their assistance.

You will see, however, that the real advances in medicine are most likely to be made by those who have the largest knowledge of science in general—it is these men who discover the new remedies which practitioners have ultimately to use, who lay down the laws which practitioners must obey. The practitioner, therefore, who may not be able to make discoveries or become a lawgiver, will still be most successful if he has laid such a foundation of science and scientific knowledge as to approach these discoverers in character and taste, to be able to recognize at once, and critically, the merit of an innovation, and, if good, to put it at once in practice; while others, who may not be able to perceive it, or who from imperfect training are doubtful of its good, and are timid about departing from the received view, lose the success its adoption might have secured them.

What I have aimed to impress upon you is the importance of devoting much time, at least the first two years of your course, to pure thorough scientific work, and to trust to the following time for the so-called professional subjects. The drudgery of the study is in the early years—you work on, hopelessly, and you seem to make no progress, when, suddenly, insight bursts upon you, you cannot tell how, and thereafter you advance rapidly and with delight. It is the work of mastering these earlier sciences which enables you to cope with those that succeed, since in them you have gained both mental training and the necessary scientific knowledge.

Some you may know who lightly value the scientific discipline, and who, at a very early period of their course, begin hospital or other professional work. For a time they may seem to proceed quickly, and you may even feel envious of their success, but the advance is fictitious, the progress is not sound, and for a delusive advantage they sacrifice the only opportunity that is quite certain, quite within reach, of laying a substantial foundation for all their future work.

Four years you have in which to be instructed in the results of medical experience from Hippocrates until now; thirty or forty years you have for acquiring your own experience; sufficient time that, for practice, without sacrificing to it one moment that can be claimed for your training. The opportunity for the latter slips past before you are aware; and after having gained the

coveted experience, it is not with unmixed satisfaction you

> "Look at the end of work, contrast
> The petty Done, the Undone vast,
> This present of yours, with the hopeful past."

Struggle therefore now to acquire the most comprehensive principles, so far as these are incontrovertibly established, remembering that every so-called "rule of experience," every merely empirical generalization, is superseded at last by the scientific law; the better you have trained yourselves when here, the higher will be the position in the profession you have chosen.

I have done, and I know not how I can more appropriately conclude than in the quaint words with which the translator of the "Englishman's Doctor, or the Schoole of Salerne"—a sort of "Domestic Medicine" or "Buchan" of the middle ages, closes his version:

> "And heere I cease to write, but will not cease
> To wish you live in health, and die in peace;
> And ye our Physicke rules that friendly read,
> God graunt that Physicke you may neuer neede."